

American Museum Novitates

PUBLISHED BY THE AMERICAN MUSEUM OF NATURAL HISTORY
CENTRAL PARK WEST AT 79TH STREET, NEW YORK, N. Y. 10024

NUMBER 2495

JUNE 30, 1972

A Jurassic Fish from Antarctica

BY BOBB SCHAEFFER¹

ABSTRACT

The first Mesozoic actinopterygian fishes from Antarctica were discovered in lacustrine interbeds within the Lower Jurassic Kirkpatrick Basalt, in the Transantarctic Mountains, Victoria Land. Except for an enigmatic patch of scales, all the specimens collected are assigned to a new genus and species, *Oreochima ellioti*, which is placed in the pholidophoriform family Archaeomaenidae. Prior to this discovery, the archaeomaenids were known only from Lower Jurassic continental deposits of Australia.

INTRODUCTION

The first collection of Mesozoic actinopterygian fishes from the continent of Antarctica was made by David H. Elliot during the austral summers of 1966–1967 and 1969–1970. The fishes, which are associated with abundant conchostracans, occur in thin sedimentary interbeds within the Kirkpatrick Basalt of the Ferrar Group (Grindley, 1963; Barrett, Elliot, and Lindsay, 1967; Barrett et al., 1968; Barrett, 1969) in the Southern Queen Alexandra Range of the Transantarctic Mountains, Victoria Land. According to K/Ar age determinations (Wade et al., 1965; Elliot, 1970), the Kirkpatrick Basalt is Lower Jurassic (179–161 million years old).

Fragmentary fish remains were first discovered near the summit of Blizzard Heights and close to the western summit of Mount Kirkpatrick. More abundant and complete specimens were later collected in the vicin-

¹ Chairman and Curator, Department of Vertebrate Paleontology, the American Museum of Natural History.

ity of Storm Peak. The interbeds containing the fish and the conchostracans consist of laminated sediments that probably represent freshwater lacustrine deposits. On the north ridge of Storm Peak there are 12 basalt flows. The sedimentary interbed above the first thick flow is about 40 cm. thick and is divisible into four units (from bottom to top): (1) a tuff with plant fragments; (2) a siliceous mudstone; (3) a laminated siliceous shale with conchostracans; and (4) a fissile shale with conchostracans (Elliot, personal commun.). Most of the fishes were found in the upper two units along the north ridge of Storm Peak. Disrupted interbeds in the same stratigraphic position yielded fish in other localities, including the east ridge of Storm Peak, a low nunatak about 3 km. east of the east ridge of Storm Peak and a poorly exposed section about 150 m. west of the principal locality on Storm Peak. A description of the lithology and petrology of the sedimentary interbeds will be published by Elliot.

With the exception of one patch of scales (AMNH 9924), all the fishes apparently belong to the same genus and species of pholidophoriform. Although the body shape, scale pattern, and fin position can be readily observed, extreme compression and fragmentation of the skull has made the dermal bone pattern practically unintelligible. However, by removing the bones and scales from selected specimens with dilute hydrochloric acid, it was possible to obtain fairly sharp impressions of the skull elements and scale details as preserved in the extremely fine-grained siliceous matrix. Smooth-on peels made from these impressions provided most of the details described below. The specimens are compressed in various aspects, with the body either straight or curled.

I am indebted to Dr. Elliot for the opportunity of describing this unique material and for providing pertinent data on the geologic occurrence. With the permission of the National Science Foundation and the Institute of Polar Studies, The Ohio State University, all the specimens will be retained on a permanent loan basis by the American Museum of Natural History (AMNH). For comparative purposes, Dr. Colin Patterson kindly arranged for the loan of an *Ichthyokentema* specimen from the British Museum (Natural History). The photographs were made by Chester S. Tarka and the drawings by Jennifer Perrott.

SYSTEMATICS

ORDER PHOLIDOPHORIFORMES

FAMILY ARCHAEOMAENIDAE GOODRICH, 1909¹

DIAGNOSIS: Fusiform pholidophoriforms attaining a length of about

¹ This family is defined here in the sense of Gardiner (1960) and Griffith and Patterson

150 mm., and differing from other families in the order Pholidophoriformes in the following combination of characters: nasals in contact behind rostral; small premaxillae in contact below rostral; circumorbital series complete; mandible with low- or well-elevated coronoid process; dentition weak, styliform; preopercular with short vertical arm, not reaching dermopterotic; opercular-subopercular suture nearly horizontal; vertebral centra, if present, annular throughout, or separated into hypocentra and pleurocentra in caudal region; scales rhomboidal with smooth or pectinated hind border, or cycloidal with smooth posterior border.

OREOCHIMA,¹ NEW GENUS

TYPE SPECIES: *Oreochima ellioti*, new species.

DISTRIBUTION: Queen Alexandra Range, Antarctica. Lower Jurassic: sedimentary interbeds of the Kirkpatrick Basalt, Ferrar Group.

DIAGNOSIS: Small fusiform pholidophoriform tentatively assigned to the Archaeomaenidae, differing from other genera in the family in having deep, irregular serrations on the posterior borders of the extrascapular, dermosphenotic, uppermost infraorbital, suborbital, preopercular, opercular, subopercular, and upper branchiostegals; in having a relatively smaller suborbital; and in having the free edges of the rhomboidal flank scales strongly serrated.

***Oreochima ellioti*,² new species**

Figures 1-8

TYPE: AMNH 9910 A and B, complete fish, part and counterpart, from interbed above first thick basalt flow of the Kirkpatrick Basalt (Lower Jurassic) of the Ferrar Group, north ridge of Storm Peak, Queen Alexandra Range, Transantarctic Mountains, Victoria Land, Antarctica.

HORIZON AND LOCALITIES: Sedimentary interbeds above first thick basalt flow, Kirkpatrick Basalt (Lower Jurassic), Ferrar Group, Blizzard Heights, Storm Peak, and Mount Kirkpatrick, Southern Queen Alexandra Range, Transantarctic Mountains, Victoria Land, Antarctica.

DIAGNOSIS: Same as for genus.

(1963) to include *Archaeomaene* Woodward, *Aphnelepis* Woodward, *Aetheolepis* Woodward, and *Madariscus* Woodward. The diagnosis includes a mixture of primitive and derived characters, which is practically unavoidable in our present state of knowledge. It is hoped that the combination in which these characters occur will provide a sufficiently restrictive diagnosis.

¹ Greek *oreos*, mountain, and *cheima*, storm, in reference to Storm Peak.

² For David H. Elliot.

REFERRED SPECIMENS¹: From Storm Peak, north ridge, lower interbed, unit 3: AMNH 9911, anterior half of fish, part and counterpart; AMNH 9912 specimen lacking caudal fin, ventral aspect; AMNH 9913, anterior third of fish, including skull; AMNH 9914, anterior third of body, incomplete skull, part and counterpart; AMNH 9915, anterior half of body, including skull, part and counterpart; AMNH 9916, complete specimen, part and counterpart; AMNH 9917, complete specimen, part and counterpart; AMNH 9918, skull and pectoral fins; AMNH 9919, skull; AMNH 9920, anterior half of body, including skull, part and counterpart; AMNH 9921, partial skull, part and counterpart; AMNH 9922, caudal fin; AMNH 9925, scales, AMNH 9926, posterior half of body; AMNH 9929, isolated vertebrae and scales; AMNH 9930, partial body with pectoral and pelvic fins; AMNH 9931, body fragment; AMNH 9932, posterior part of body; AMNH 9933, body lacking skull and caudal fin; AMNH 9934, body fragment with skull; AMNH 9935, body fragment with pectoral fins; AMNH 9936, partial body and skull; AMNH 9937, posterior half of body, including impression of caudal fin; AMNH 9938, posterior half of body, part and counterpart; AMNH 9940, three fragmentary individuals, part and counterpart; AMNH 9941, posterior half of body, part and counterpart; AMNH 9942, scales, part and counterpart; AMNH 9943, section of body with dorsal fin, part and counterpart; AMNH 9944, fragment of skull and pectoral fin; AMNH 9945, partial body with skull, part and counterpart; AMNH 9946, scales and centra; AMNH 9947, scales; AMNH 9948, body fragment; AMNH 9949, anterior body fragment with centra, part and counterpart; AMNH 9950, posterior half of body, with dissociated caudal fin, part and counterpart; AMNH 9951, anterior third of body; AMNH 9952, section of body with centra, part and counterpart; AMNH 9953, anterior part of skull; AMNH 9954, posterior half of body, part and counterpart; AMNH 9955, scales and centrum; AMNH 9956, partial skull impression, ventral aspect; AMNH 9957, partial skull and body; AMNH 9958, skull and anterior part of body, part and counterpart; AMNH 9967, distorted portion of body, part and counterpart; AMNH 9968, skull and partial body; AMNH 9969, anterior part of body, including skull, part and counterpart; AMNH 9970, section of body, part and partial counterpart; AMNH 9971, section of body, part and counterpart.

From Storm Peak, north ridge, lower interbed, unit 4: AMNH 9923, partial fish, including skull, part and counterpart; AMNH 9939, section

¹ In addition to the specimens listed, there are some 50 fragmentary and poorly preserved specimens that have not been catalogued.

of body from pectorals to dorsal fin; AMNH 9959, posterior skull and anterior body, part and counterpart; AMNH 9960, distorted skull and body to caudal fin, part and counterpart; AMNH 9961, partial distorted skull; AMNH 9963, scales; AMNH 9964, partial skull, opercular, part and counterpart; AMNH 9965, scales; AMNH 9966, anterior part of body, including skull, part and counterpart.

From Storm Peak, 150 m. west of locality on north ridge: AMNH 9972, section of trunk with impressions of centra, part and counterpart.

From Storm Peak, nunatak 3 km. east of east ridge: AMNH 9928, body with caudal fin and skull, part and counterpart.

DESCRIPTION

BODY FORM AND MEASUREMENTS: Each of two nearly complete specimens of *Oreochima ellioti* (AMNH 9910 and AMNH 9916) has a total length of about 60 mm., and the incomplete specimens represent individuals of similar size. Measurements (in mm.) of the type specimen (AMNH 9910) are as follows:

Total length	60
Tip of snout to fork of caudal fin	50
Tip of snout to posterior border of opercular	13
Tip of snout to origin of pelvic fin	27
Tip of snout to origin of dorsal fin	31
Tip of snout to origin of anal fin	38
Maximum depth of body	14

SNOUT AND SKULL ROOF: Although the snout is not clearly defined, several specimens (AMNH 9911, AMNH 9918, AMNH 9920, AMNH 9923) show that the nasals extend beyond the anterior borders of the frontals and meet in the midline. A somewhat triangular element in AMNH 9911 and AMNH 9920 appears to be the rostral. The premaxillae are situated below the rostral and meet in the midline.

The frontals taper anteriorly and are slightly notched where they are in contact with the nasals. They are broadest posteriorly, where the width of each is about half its total length. The rectangular parietals are about half the length of the frontals. The dermopterotics, which are somewhat narrower than the parietals, have an anterolateral extension bordering the parietals that carries the main cephalic sensory canal to the dermosphenotics.

OPERCULAR SERIES AND CHEEK AREA: The opercular bone is about twice as high as the subopercular. The suture between them is nearly horizontal. Strong, irregular serrations are present along the posterior edge of each element. The interopercular also has at least one serration

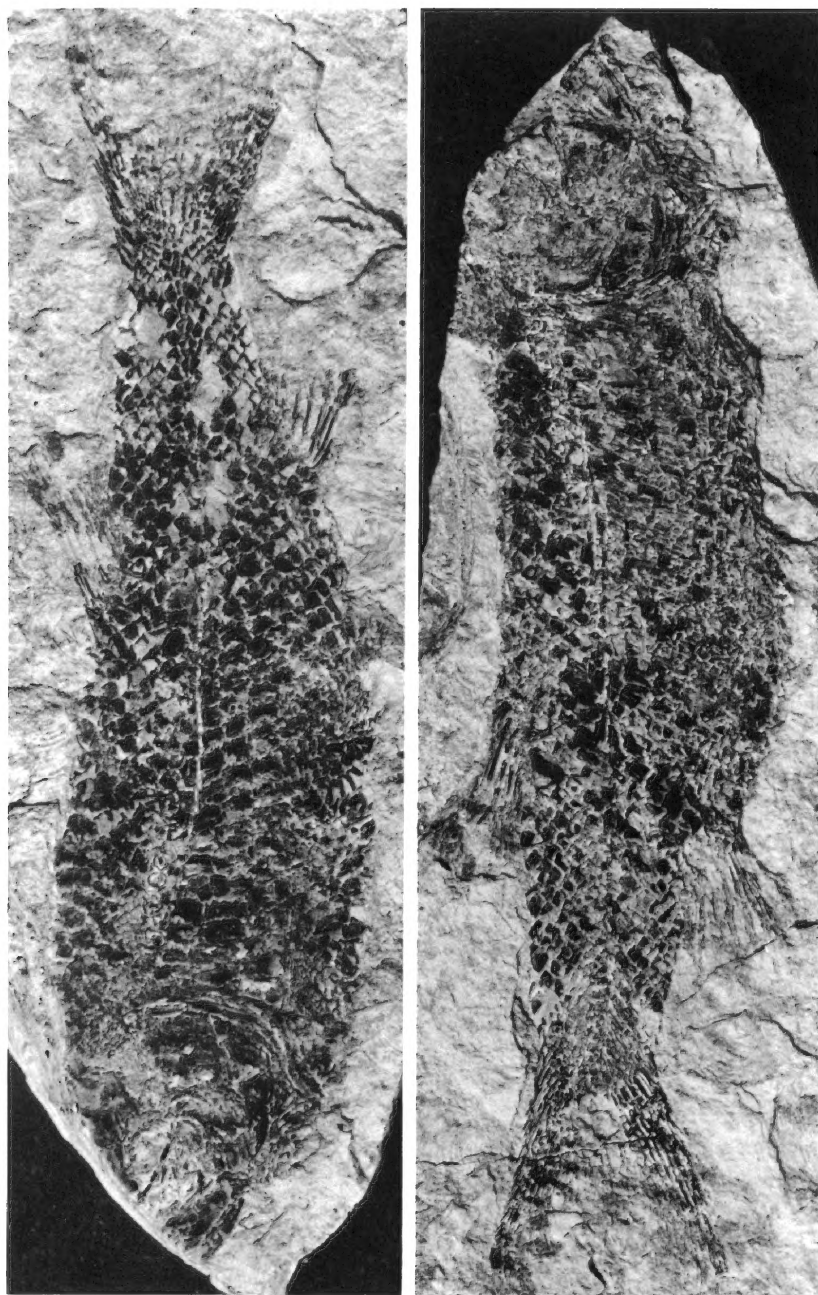


FIG. 1. *Oreochima ellioti*, new genus and species, AMNH 9910, type specimen, part and counterpart. Ca. $\times 2.5$.

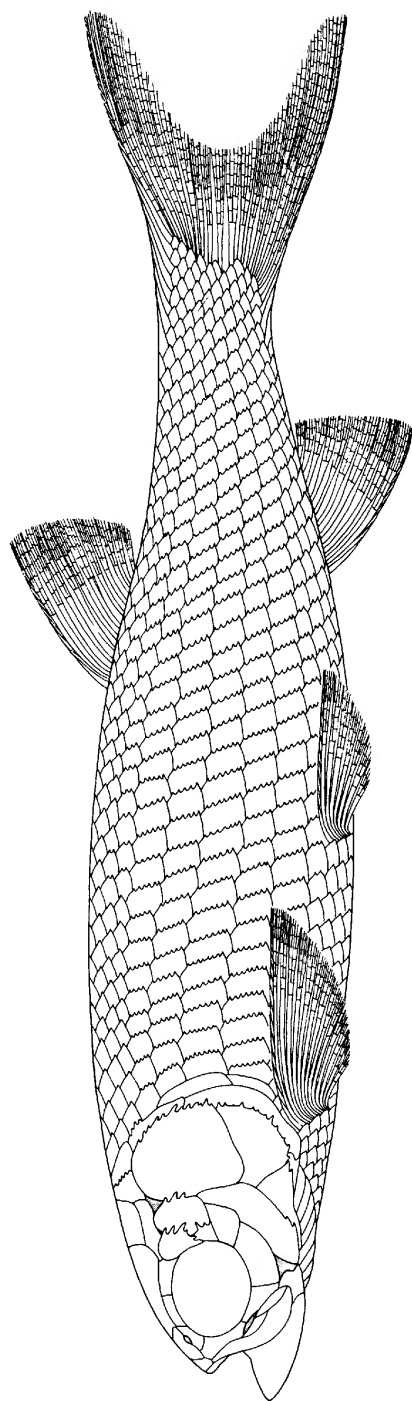


FIG. 2. *Oreochima elliotti*, new genus and species. Restoration in lateral aspect. Ca. $\times 2.75$.

on its posteroventral edge. The preopercular has a short vertical arm that terminates near the ventral border of the suborbital rather than at the lateral border of the dermosphenotic. The 11 branchiostegal rays in AMNH 9918 represent the maximum observed number. Bluntly pointed serrations occur on the posteroventral borders of a few posterior branchiostegals. A median gular plate can be seen in AMNH 9912.

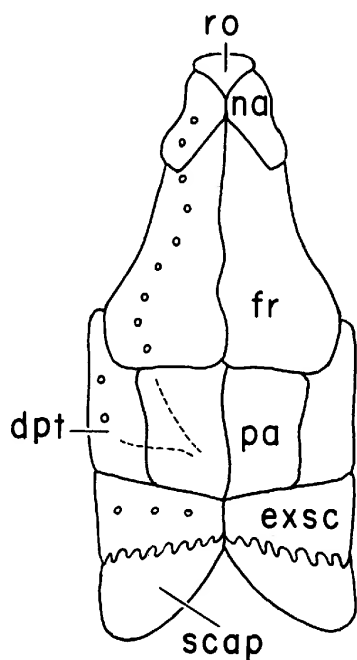
The single ovate suborbital lies above and anterior to the preopercular and is separated from the orbit by the dermosphenotic and the uppermost element in the infraorbital series. All these bones have irregularly serrated posterior borders. The two infraorbitals in contact with the preopercular are as wide as the suborbital and have smooth edges. The infraorbital above the mandible tapers anteriorly to meet the nearly triangular antorbital. There are at least two barlike supraorbitals.

JAWS: The slim, arcuate maxilla, which supports two overlapping supramaxillae, has a well-developed ethmoid process and extends posteriorly to the middle of the orbit. The detailed form of the premaxilla cannot be determined, but it is evident that it is situated below and anterior to the rostral and ethmoid process of the maxilla, as it is in the pholidophorids. Minute teeth are present on the premaxilla and possibly on the maxilla.

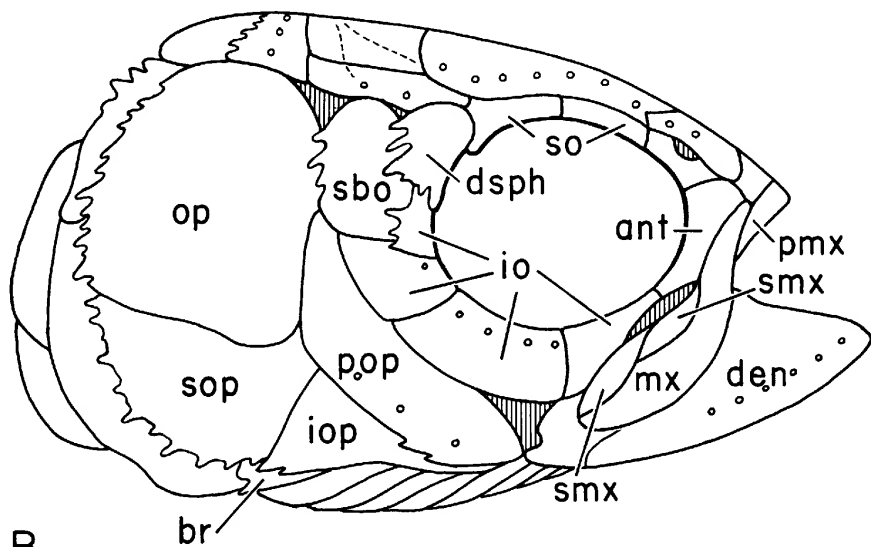
The isolated right mandible in AMNH 9912 is similar in general aspect to that of the pholidophorids (Nybelin, 1966, pl. 15), the ichthyokentemids (Griffith and Patterson, 1963), and probably to most of the Australian archaeomaenids (Wade, 1941). Anteriorly, the dentigerous margin of the dentary forms a low arc from the symphysis to the coronoid process. At least one row of minute, conical, closely spaced teeth occurs along this margin. The dorsal border of the extended coronoid process nearly parallels the ventral margin of the mandible. Posteriorly, the angular, which is about one-third the size of the dentary, slopes abruptly to the articular facet.

SENSORY CANAL SYSTEM: The supraorbital canal has two or three pores in the nasal. It continues through the frontal, with perhaps eight pores, and enters the parietal at its anterolateral corner. Within the parietal it is confluent with the well-defined anterior pit line. The infraorbital canal follows its usual course through the infraorbital series, the dermosphenotic and into the extrascapular and suprascapular (cephalic division of main lateral line). There is no connection between the supraorbital and infraorbital canals.

Because of the short vertical limb of the preopercular, the connection of the preopercular canal with the infraorbital canal (or cephalic division of the main lateral line) cannot be ascertained. It is probable, however, that



A



B

FIG. 3. *Oreochima ellioti*, new genus and species. Restoration of skull. A. Dorsal aspect. B. Lateral aspect. Both ca. $\times 6.5$.

Abbreviations: ant, antorbital; br, branchiostegal; den, dentary; dsph, dermo-sphenotic; dpt, dermopterotic; exsc, extrascapular; fr, frontal; io, infraorbital; iop, interopercular; mx, maxilla; na, nasal; op, opercular; pa, parietal; pmx, premaxilla; pop, preopercular; ro, rostral; sbo, suborbital; scap, suprascapular; so, supraorbital; sop, subopercular; smx, supramaxilla.

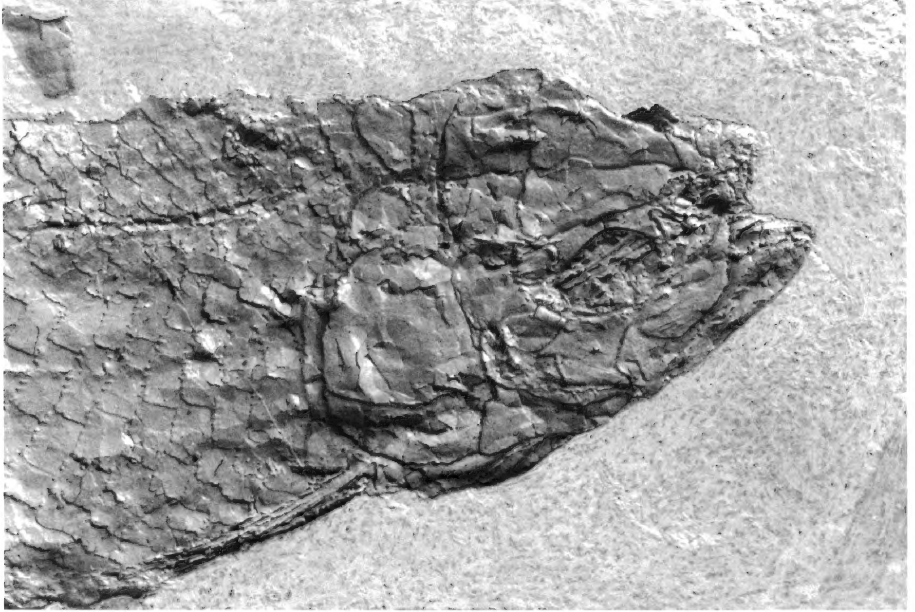


FIG. 4. *Oreochima ellioti*, new genus and species, AMNH 9911. Skull and anterior part of body. Ca. $\times 5$.

these two canals are joined at the posterolateral corner of the dermopterotic, as suggested by Nybelin (1966) for *Pholidophorus*.

VISCERAL SKELETON: Dissociated elements of the visceral skeleton are exposed in several specimens. When the restored palate of *Ichthyokentema* (Griffith and Patterson, 1963) is used as a guide, the incomplete right palate of AMNH 9915 can be interpreted as having a toothed entopterygoid, a narrow ectopterygoid, and a metapterygoid with paired dorsal processes. The hyomandibular (AMNH 9915) has a prominent opercular process and in most details resembles that of *Ichthyokentema*. A ceratohyal is evident in AMNH 9915, again rather like that of *Ichthyokentema*.

Parts of five gill arches can be distinguished in AMNH 9920 and AMNH 9923. In AMNH 9923 two symmetrical tooth plates lie between the gill arch elements and the anteriorly displaced left opercular and subopercular. Both plates probably belong to the basibranchial series. Another patch of teeth occurs on the inner surface of the entopterygoid. The ventral surface of the parasphenoid has not been observed, but it is very probably dentigerous.

AXIAL SKELETON: The thoracic and abdominal centra, which can be seen on end in several specimens (e.g., in AMNH 9910 and AMNH 9920), are thin continuous cylinders of dense bone. Fragments of the neural

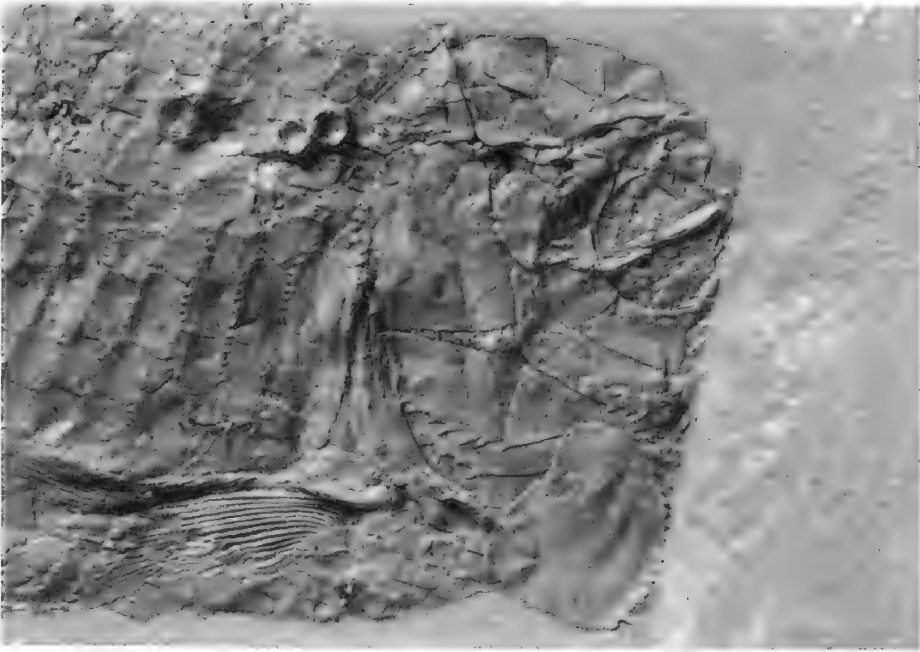


FIG. 5. *Oreochima ellioti*, new genus and species, AMNH 9920b. Cheek region and anterior part of body. Ca. $\times 5$.

arches and spines show that these structures are thin and delicate. Parts of the ribs evident in the type specimen (AMNH 9910) show that they are fairly long and internally cancellous. The total number of vertebrae cannot be ascertained, but it must be more than 40. Intermuscular bones have not been observed.

PAIRED APPENDAGES: The extrascapulars have a broad contact with each other. Their posterior borders are serrated. The position of the supratemporal commissural canal is indicated by four or five pores in each element. The somewhat larger suprascapulars have smooth borders and barely meet each other at the midline. Several pores along the lateral edges show the course of the lateral line canal.

The dermal shoulder girdle is well defined in AMNH 9920. The nearly lanceolate supracleithrum is serrated along its posterodorsal border. This element typically overlaps the attenuated dorsal end of the cleithrum. There are two postcleithra: the dorsal one is about three times as high as the ventral one. The endoskeletal pectoral girdle, although exposed in several specimens, is too fragmentary for description.

The pectoral fins (AMNH 9912) are composed of about 13 rays that are segmented and distally branched. Delicate fringing fulcra are present

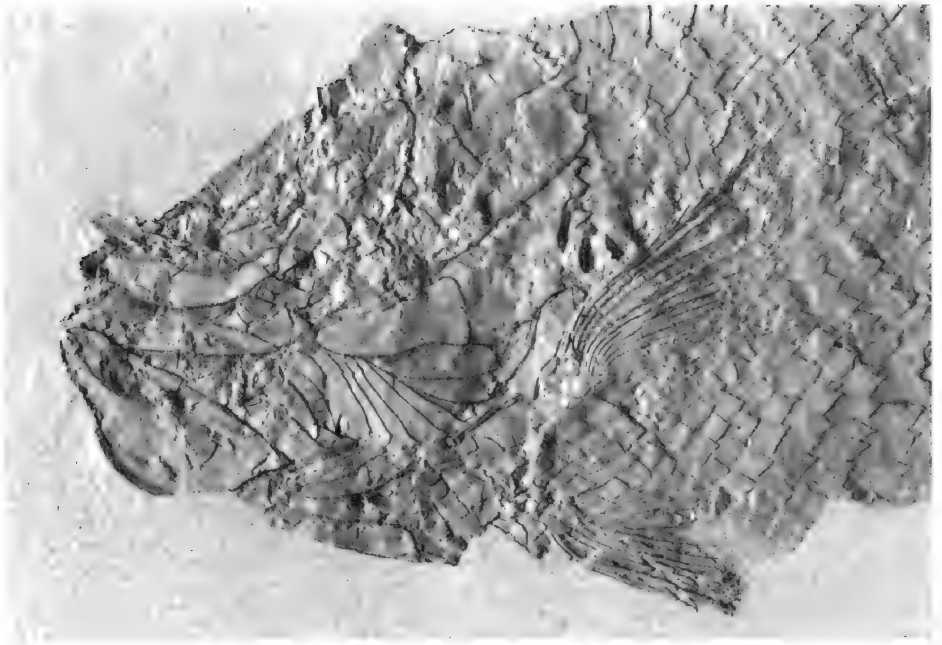


FIG. 6. *Oreochima elliotti*, new genus and species, AMNH 9912. Partly dissociated skull with mandible. Ca. $\times 5$.

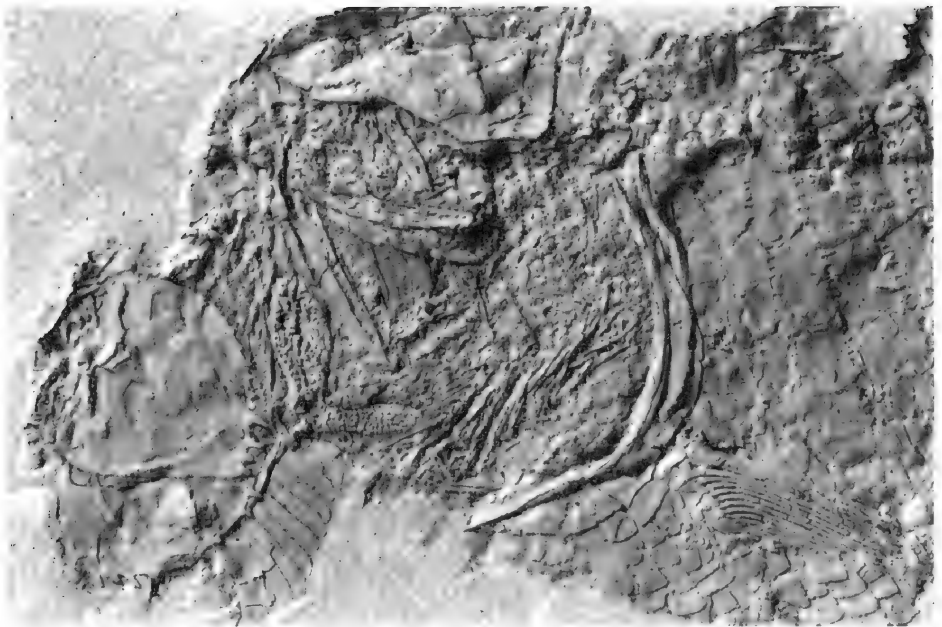


FIG. 7. *Oreochima elliotti*, new genus and species, AMNH 9923. Dissociated skull showing gill arches and presumed basibranchial tooth plates. Ca. $\times 5$.

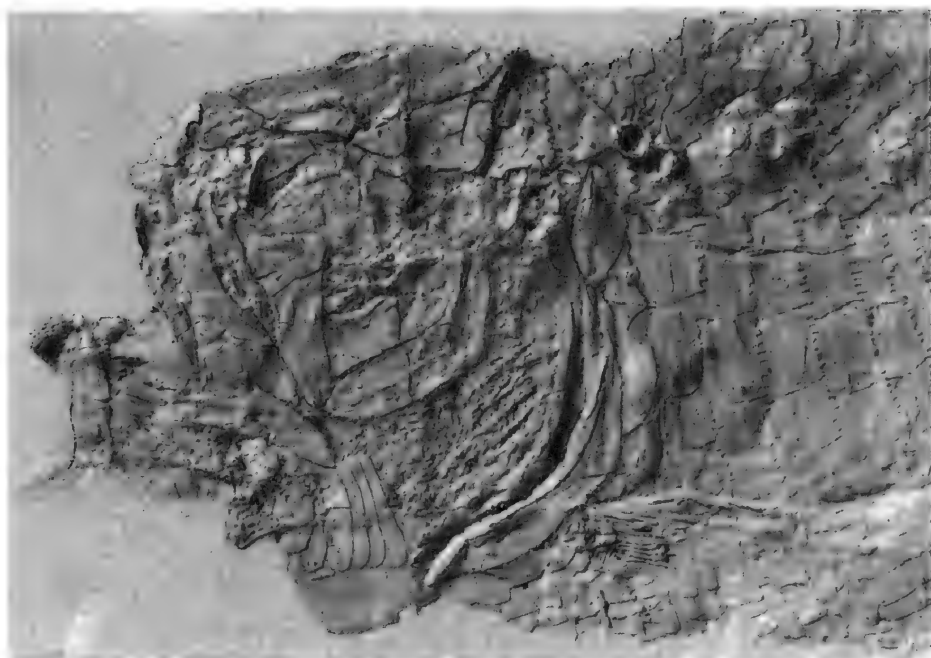


FIG. 8. *Oreochima ellioti*, new genus and species, AMNH 9920a. Partly dissociated skull and complete shoulder girdle. Ca. $\times 5$.

along the outer border of the first ray. The outermost pectoral rays extend posteriorly to within a few vertical scale rows of the pelvic fin base.

The pelvic fins, also well displayed in AMNH 9912, include about seven rays. These are segmented and branched in their distal half. The first ray supports at least one basal fulcrum, and it is followed by a series of fringing fulcra.

UNPAIRED FINS: The dorsal fin, which is best preserved in the type specimen (AMNH 9910), is situated about midway along the dorsal border. It originates five scale rows behind the origin of the pelvics and is composed of about nine distally segmented and branched rays. The first ray is bordered by at least two basal fulcra and an indeterminable number of fringing fulcra.

The anal fin (AMNH 9910 and AMNH 9912) is situated roughly halfway between the pelvic and caudal fins. Its origin is five vertical scale rows behind that of the dorsal fin. It consists of nine well-spaced distally segmented and branched rays. The first ray is bordered by two basal fulcra and numerous fringing fulcra.

The caudal fin is equilobate and hemiheterocercal. It includes 17 segmented and branched principal rays. The base of the epaxial lobe is

bordered by a large caudal scute followed by five basal fulcra. Fringing fulcra extend along the entire dorsal margin. There is a single caudal scute at the base of the hypaxial lobe, followed by short undivided segmented rays and fringing fulcra. An attempt was made to expose the caudal skeleton in several specimens but because of crushing and thin ossification only a portion of this complex area can be deciphered. At least eight separate hypurals are evident, arranged as they are in *Pholidophorus* (Patterson, 1968). Other details remain problematical.

SQUAMATION: The scales are rhomboidal and smooth. They have a typical peg-and-socket articulation between their dorsal and ventral edges. The anterior flank scales are about twice as deep as wide and are strongly denticulated. Dorsal, ventral, and posterior to the flank area the scales decrease in size, and the denticulation is ultimately reduced to a single projection on the posteroventral corner. In the abdominal region the scales are about half as deep as they are wide.

In thin section the scales show a lepisosteoid pattern, with a well-developed ganoine layer covering laminated bone — as in *Pholidophorus* sp. (Schultze, 1966, fig. 46a) and *Ichthyokentema* (Griffith and Patterson, 1963). The cell spaces are prominent and the canals of Williamson are widely spaced.

DISCUSSION

In the details of the dermal skull, *Oreochima* most nearly resembles members of the Pholidophoridae, *sensu stricto* (Nybelin, 1966), the Archaeomaenidae (Wade, 1941), and the Ichthyokentemidae (Griffith and Patterson, 1963). It shows no evident relationship with the other pholidophoriform families — the Pleuropholidae (Saint-Seine, 1949, 1955), the Ligulellidae (Saint-Seine, 1955), the Majokiidae (Saint-Seine, 1955), or the Galkiniidae (Yakovlev, 1962).

A comparison of characters in *Oreochima* and the other archaeomaenids with the same characters in the pholidophorids and ichthyokentemids, and in various holostean and “subholostean” families (such as the parasemionotids) suggests that the primitive pholidophoriform condition for each character is as follows:

1. Premaxillae in contact below rostral.
2. Nasals in contact behind rostral, but partly separated by frontals.
3. Parietal rectangular.
4. Dermopterotic with fairly broad anterior extension bordering frontal.
5. Extrascapular triangular.
6. Circumorbital ring complete, with one enlarged infraorbital below single suborbital of nearly same size.
7. Maxilla arcuate, extending to middle or posterior border of orbit.

8. Supramaxilla represented by one or two elements.
9. Mandible with high, elongated coronoid process.
10. Dentition weak.
11. Preopercular narrow ventrally and extending dorsally to dermopterotic.
12. Opercular-subopercular suture nearly horizontal.
13. Notochord unconstricted.
14. Centra chordal, annular.
15. Caudal skeleton composed of 10 or more similar hypurals.
16. Scales rhomboidal and lepisosteoid.

On the basis of the foregoing list, the following character states in the pholidophorids may be regarded as derived:

1. Nasals separated by frontals.
2. Extrascapular lobate.
3. Dermopterotic with narrow anterior extension.
4. Circumorbital ring probably incomplete dorsally.
5. Preopercular enlarged ventrally, does not extend to dermopterotic.
6. Opercular triangular; suture with subopercular oblique.

For the ichthyokentemids, the separation of the premaxillae by the dentigerous rostral is presumably derived. Otherwise this family is seemingly replete with primitive character states. More or less the same level of primitiveness is evident in the archaeomaenids. However, the short vertical arm of the preoperculum and the cycloid scales of *Archaeomaene* and *Madariscus* are undoubtedly derived.

Oreochima shares most of the primitive pholidophoriform characters discussed above. On the basis of its snout pattern and the shortened vertical ramus of its preopercular, it may be assigned to the Archaeomaenidae. The main differences between *Oreochima* and the Australian archaeomaenids are the relatively smaller suborbital and the denticulated dermal bones and scales in *Oreochima*. Griffith and Patterson (1963) have suggested that the Australian genera may be separated into two groups: (1) *Aetheolepis* and *Aphnelepis*, which have rhombic scales that are somewhat deepened on the flank; and (2) *Archaeomaene* and *Madariscus*, which have thin cycloidal scales. *Oreochima* has the scale type of the first group and also shares with it an enlarged second infraorbital below the dermosphenotic. It therefore seems that *Oreochima* is most closely related to *Aetheolepis* and *Aphnelepis*; however, it is more primitive than either in having a small suborbital. If we assume that the Archaeomaenidae, as here delimited, were entirely freshwater, their presence in both Australia and Antarctica during the Jurassic is not surprising, as these two continents were in contact throughout the Mesozoic. The high proportion of shared primitive character states (and the concomitant paucity of derived ones, either shared or unique) in the pholidophorids, ichthyokentemids, and arch-

aeomaenids makes it difficult to postulate the interrelationships of these families.

LITERATURE CITED

- ANDREWS, S. M., B. G. GARDINER, R. S. MILES, AND C. PATTERSON
1967. Pisces. In Harland, W. B., et al. (eds.), *The fossil record*. Geol. Soc. London, pp. 637-683.
- BARRETT, P. J.
1969. Stratigraphy and petrology of the mainly fluviatile Permian and Triassic Beacon rocks, Beardmore Glacier area, Antarctica. *Inst. Polar Studies Rept. no. 34*, xi+123 pp.
- BARRETT, P. J., D. H. ELLIOT, J. GUNNER, AND J. F. LINDSAY
1968. Geology of the Beardmore Glacier area, Transantarctic Mountains. *Antarctic Jour. U. S. (Nat. Sci. Found.)*, vol. 3, no. 4, pp. 102-106.
- BARRETT, P. J., D. H. ELLIOT, AND J. F. LINDSAY
1967. Geology of the Beardmore Glacier area. *Antarctic Jour. U. S. (Nat. Sci. Found.)*, vol. 2, no. 4, pp. 110-112.
- ELLIOT, D. H.
1970. Jurassic tholeiites of the central Transantarctic Mountains, Antarctica. In Gilmour, E. H., and D. Stradling (eds.), *Proceedings of the second Columbia River basalt symposium*, East Washington State College, Cheney, Washington, March 21-23, 1969. Cheney, Washington, East Washington State College Press, pp. 301-325.
- GARDINER, B. G.
1960. A revision of certain actinopterygian and coelacanth fishes, chiefly from the Lower Lias. *Bull. British Mus. (Nat. Hist.)*, Geol., vol. 4, no. 7, pp. 241-384.
- GOODRICH, E. S.
1909. Vertebrata craniata (First fascicle: Cyclostomes and fishes). In Lankester, R. (ed.), *A treatise on zoology*. London, Adam and Charles Black, pt. 9, xvi+518 pp.
- GRIFFITH, J., AND C. PATTERSON
1963. The structure and relationships of the Jurassic fish *Ichthyokentema purbeckensis*. *Bull. British Mus. (Nat. Hist.)*, Geol., vol. 8, no. 1, pp. 1-43.
- GRINDLEY, G. W.
1963. The geology of the Queen Alexandra Range, Beardmore Glacier, Ross Dependency, Antarctica; with notes on the correlation of Gondwana sequences. *New Zealand Jour. Geol. Geophys.*, vol. 6, no. 3, pp. 307-347.
- LEHMAN, J.-P.
1966. Actinopterygii. In Piveteau, J. (ed.), *Traité de paléontologie*. Paris, Masson et Cie., vol. 4, vol. 3, pp. 1-242.
- NYBELIN, O.
1966. On certain Triassic and Liassic representatives of the family Pholidophoridae s. str. *Bull. British Mus. (Nat. Hist.)*, Geol., vol. 11, no. 8, pp. 351-432.
- PATTERSON, C.
1968. The caudal skeleton in Lower Liassic pholidophorid fishes. *Bull. British Mus. (Nat. Hist.)*, Geol., vol. 16, no. 5, pp. 201-239.

ROMER, A. S.

1966. Vertebrate paleontology. (Third edition). Chicago and London, The University of Chicago Press, ix+468 pp.

SAINT-SEINE, P. DE

1949. Les Poissons des calcaires lithographiques de Cerin (Ain). *Nouv. Arch. Mus. Hist. Nat. Lyon*, fasc. 2, vii+357 pp.
1955. Poissons fossiles de l'étage de Stanleyville (Congo belge). Première partie. La faune des argilites et schistes bitumineux. *Ann. Mus. Roy. Congo Belge, Sci. Géol.*, vol. 14, xix+126 pp.

SCHULTZE, H. P.

1966. Morphologische und histologische Untersuchungen an Schuppen mesozoischer Actinopterygier (Übergang von Ganoid- zu Rundschuppen). *Neues Jahrb. Geol. Paläont. Abhandl.*, vol. 126, no. 3, pp. 232-314.

WADE, F. A., V. L. YEATS, J. R. EVERETT, D. W. GREENLEE, K. E. LAPRADE, AND J. C. SHENK

1965. The geology of the central Queen Maud Range, Transantarctic Mountains, Antarctica. *Texas Tech. College Antarctic Rept.*, ser. no. 65-1, 54 pp.

WADE, R. T.

1941. The Jurassic fishes of New South Wales. *Jour. Proc. Roy. Soc. New South Wales*, vol. 75, pp. 71-84.

YAKOVLEV, V. N.

1962. (Fishes of the order Pholidophoriformes in the Jurassic of Karatau.) [In Russian] *Paleont. Zhur.*, vol. 3, pp. 90-101.

